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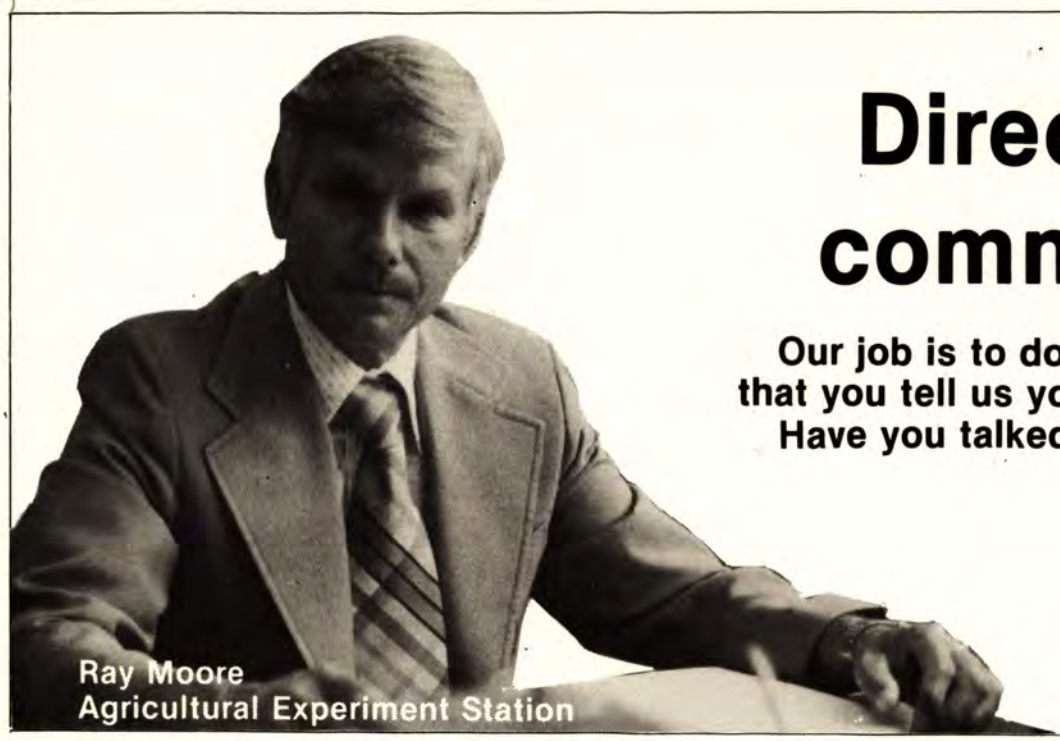


Director's comments

Our job is to do the research that you tell us you want done. Have you talked to us lately?

What do **you** have to say about what we do at the Experiment Station? How do we determine what research projects we start?

The citizens of South Dakota have everything to say about our work. We want our Experiment Station to be doing the kind of research that the majority of the people of the state want. We welcome all the help we can get and seek it often.

One way we find out what you want is through advisory boards. You or your neighbor may already serve on one of these boards. We hear of people who want to participate either directly, through Extension county agents, or from crop and livestock associations.

Other ways we seek out the trends in this state are through commodity and user groups. And county agents are continually assessing the research needs in their communities and sending the message back to us through Extension specialists or supervisors or college department heads.

Private citizens have the same opportunities. Write us directly, call, stop in and visit, or contact any of the people mentioned.

The research we undertake must relate to goals you have set for us. We cannot always accommodate every request we get. There are several reasons.

We do have limitations of personnel and dollars. Frequently, the research has already been done and we need only send a copy of the published results to you. Other times the research has been completed but the results not yet published. Your request speeds this process.

Occasionally there is a request for research that does not match the purpose of the Agricultural Experiment Station; or we don't have the talent, facilities, or equipment to do the study properly. Our greatest limitation, however, is a rather small staff with limited funds working very hard on a current task.

It seems, however, that we can always set something aside to work on fast-breaking problems of genuine importance. The Hessian fly outbreak of 1978 is a good example. Alcohol fuel research and solar energy are others.

Each annual report of this magazine has a list of all ongoing projects. We'd be happy to send you a copy as well as up-to-date progress reports on the projects you're interested in. We can also put you in direct contact with the project leader.

Don't let the word "research" put you off. Look at it this way: our people work in every field that affects your life. In just this one issue of *Farm & Home Research* are stories that bear this out: reports on more efficient silage making, the worsening South Dakota road situation, and a new bromegrass variety, for example.

Get acquainted with our people. They have made sizable contributions to your lives in the past, and will continue to do so in the years ahead. □

Roads: abandonment and more taxes

Tempers are building over roads just as they did over rail lines. Best answer could be a single integrated network

You're into the chuckhole before you know it. You just drop in and jolt through; what else is there to do? In the back, the tool box hops and settles again. There's even more breakup ahead.

Ahead, too, are some tough choices to make about this road and the many like it in South Dakota.

Those decisions will be made in much the same agony and political ferment as the ones that have gone with the railroad situation in South Dakota, says A. Clyde Vollmers, agricultural marketing specialist at SDSU.

"Just as rail lines have been abandoned, some roads may have to be abandoned, too," he says. "The highway and road system serving South Dakota is rapidly deteriorating, and many miles are no longer adequate for commerce and agriculture.

"But neither the state nor local units of government have enough funds to maintain existing roads and the situation is getting worse."

South Dakota has 81,500 miles of highways, roads, and streets. That's more miles of road per person than any other state except North Dakota. But when Vollmers puts that figure beside South Dakota's low per capita income—he shakes his head.

The two figures reveal proportionately little tax money to do a huge amount of road work.

The specialist says South Dakota roads tally up like this:

Interstate system	678 miles
Federal aid roads	
State primary	5,877 miles
State secondary	2,446 miles
County and city	8,286 miles
Local rural and city	64,200 miles
Total	nearly 81,500 miles

Of course, the interstate system provides a fast, direct link between farmers and their markets, but the remaining 80,000 plus miles are what concern Vollmers.

Aside from interstates, road situation looks calamitous

"The heart of the highway and road system serving South Dakota's agriculture is the 5,877 miles of federal aid primary highways," he says. "But 800 miles of these need immediate resurfacing before they deteriorate to the rebuilding stage.

"The cost of rebuilding highways is approximately four and one half times the cost of resurfacing," he adds.

In 1978, South Dakota spent $101 million for highway maintenance, which was well above the $69 million spent in 1968. However, with increased costs and inflation, the 1978 dollars bought 40% less highway than the 1968 expenditure.

The 2,446 miles of secondary state highways include two types of roads. Thirty percent are scenic and perimeter highways and the remaining 70% serve agricultural interests. Vollmers explains that, by state law, 8% of all funds received by the Department of Transportation from state sources must be allocated to these roads.

"The result of this law is that nearly all secondary road funding goes to the scenic and perimeter highways, leaving nothing to maintain the secondary roads serving agriculture."

Then comes the 8,286 miles of county roads and city streets which are in the federal aid system. Many of these are hard-surfaced and provide quality roads for farmers. The cost of improving these roads to federal standards is unknown, but the condition of the older rural roads is described by a county highway superintendent as "slowly going down hill."

Most roads in South Dakota are local rural roads or city streets which include city, county, and township roads not in the federal aid system. According to Vollmers these

"farm door" roads account for 64,200 miles, or 89% of the state's road mileage.

"The exact condition of these roads has not been completely determined," Vollmers says.

But he notes the liklihood that many of these roads and the bridges on them were built before 1935 and were designed to carry 6-7 ton loads. Consequently, the width, bases, and capacities of these roads and bridges were designed to meet traffic needs of the 1930's and 1940's. Since 1950, however, farm truck capacity and machinery size has increased substantially. And more grain is moving, from increased yields and railroad abandonment.

Our choices narrow the longer we put off comprehensive plan

The situation sounds dismal? Indeed. But several types of action are possible.

Vollmers maintains that, "the state can design an effective transportation system to meet the needs of the 21st century. We must remember, though, that there's no free lunch. Highways cost money. We can expect some increase in taxes, some abandoment of roads, and a lot of careful economic evaluation."

After such evaluation some of the alternatives Vollmers suggests state and local governments probably will use—depending on varying situations—include:

1. Reduced speed and weight limits. If enforced, this can keep road maintenance costs down. But driver or user costs will increase.

2. Reduced maintenance standards. Such standards as right-of-way width, shoulder and bridge widths, pavement thickness, and maximum grades could all be reduced. However, as standards are reduced, maintenance costs increase. The costs of operating vehicles and numbers of traffic accidents would also increase.

3. Continued present policy. Tax increases are avoided by continuing existing spending for roads. But the present overall policy is resulting in deterioration of the roads serving agriculture. Furthermore, as bridges and roads deteriorate and become dangerous, the state and counties can face more large tort liability claims for damages.

The sign and the bridge railing probably were knocked askew by both modern farm machinery and old age. This bridge and road, like many "farm door" roads built 30 or 40 years ago, were not designed for traffic of the 1970's. Such roads account for 89% of the state road milage; the money is hardly available for minimum upkeep, let alone improvement.

"There's no free lunch," says A. Clyde Vollmers, former SDSU marketing specialist. Although we can design a workable transportation system for the future, taxes will go up and some roads will be abandoned.

4. Shifted responsibility between county and state. Some local government officials want counties and cities to receive a larger share of gas tax revenue. And state authorities sometimes want to shift ownership of some state highways to counties. However, doing either only changes responsibility and does not change revenue needs.

5. Increased state and local taxes. This is obviously no popular subject, but the level of taxation does determine the quality level of highways. Governmental units also need to determine other sources of revenues, such as gas taxes and property taxes.

6. More federal funding. Federal funding in South Dakota would probably have to be at least doubled to solve the road problem for all systems in the state. The current national taxpayer mood indicates that won't happen. By resolving the billboard problem, South Dakota will gain an extra $4 million, an improvement, but certainly not a solution.

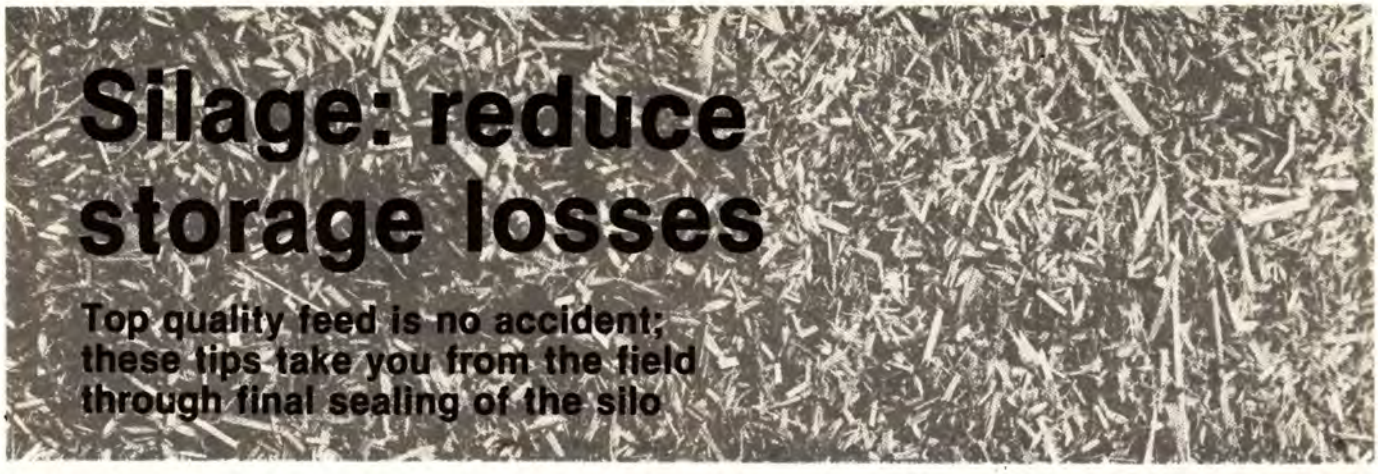
7. Abandonment of selected roads. A rural road which once served several families may now serve only one farm. County governments say that such a road is essentially a personal driveway. Some of these roads will be abandoned. The only question is, how many and which ones?

8. Integration of rail and highway systems. The most efficient solution may be to integrate the two systems into one grain marketing network. This would involve abandonment of both rail lines and roads. Farmers may bear increased marketing costs from reduced service. But maintaining both systems would result in even higher costs for the farmer from increased tax burdens. The problem is whether enough funding is even available to meet the needs of a rationalized system.

Vollmers points out that "while the alternatives are not pleasant, decisions need to be made. Roads and bridges cost money. The question is, what level of service will South Dakota people support and sustain?"

It will be no easy ride. The chuckholes and breakups awaiting us as we make our way to a workable decision are every bit as deep and jarring as those on our roads today. □

The writer is Jacqueline Ullery, assistant information specialist, Ag Information Office.



Silage: reduce storage losses

Top quality feed is no accident; these tips take you from the field through final sealing of the silo

R. K. McGuffey

Much of the meat, milk, and wool produced in South Dakota is based upon the feeding of forages, for today's trend is to feed more silage and less hay.

South Dakota is a leading state in corn harvested for silage. When the acres of alfalfa, small grains, and sorghum that are made into silage each year are added in, you can see the importance of silage and the silage making process to agriculture in South Dakota.

Silage has gained in use because (1) greater yields of nutrients per acre are possible; (2) less harvesting losses and higher forage quality result; and (3) almost total mechanization of harvesting and feeding reduces labor costs.

On the other hand are the disadvantages: (1) the large cost of machinery, storage and feeding facilties; (2) no ready off-farm market; and (3) high storage losses if crops are not harvested correctly. The discussion which follows is aimed at management techniques to reduce storage losses.

Delicate balance in the silo can be destroyed by a misstep on your part

A crop is preserved in the silo by a process called fermentation. Whether this crop is cabbage for sauerkraut or corn for silage, the principles of preservation are the same.

When a crop is harvested, the plant continues to respire. As plants respire they burn sugar, use oxygen, and give off carbon dioxide, water, and heat. Aerobic bacteria are present all around that respire also. During filling of the silo, oxygen is trapped in the silage mass. Plant cells and aerobic bacteria utilize this oxygen to convert soluble sugars to carbon dioxide, water, and heat. As oxygen is depleted, the plant cells and aerobic bacteria die. The aerobics are replaced by anaerobic (not requiring oxygen) bacteria. This new class of bacteria begins the fermentation. The soluble sugars are converted to lactic acid and small quantities of other acids, lowering pH of the mass. Fermentation continues until the pH of the silage decreases to 4.0 to 4.5. At this low pH the silage is "pickled" and a stable product is formed which, if left undisturbed, can be stored almost indefinitely.

Especially at this point, care must be taken to exclude air from entering the preserved silage. When air reenters, refermentation can occur. Putrefactive microrganisms called *Clostridia* convert lactic acid to butyric acid. Protein is destroyed, resulting in large amounts of ammonia being formed. The pH increases, molds and yeasts begin to proliferate, and heating occurs. The resulting silage becomes a foul smelling, low quality material that is poorly consumed and has little nutritional value to it.

Successful production of high quality silage is no accident. There are several management steps to take prior to harvesting for silage. Some are general and apply to all crops for silage, and some are crop specific.

Best silage management starts at cutting, goes to final seal

1. Harvest at the correct stage of maturity.

The quality of feed produced can be no better than that from which it was made. Each crop has a limited period of time when both quality and quantity are optimal. Harvesting during this period increases the chances of producing top quality silage.

2. Keep harvesting equipment in good condition.

Nothing can be more frustrating than a breakdown due to a lack of preventive maintenance. Check each piece of equipment daily to insure top-notch performance. Many tons of silage can be harvested each day when everything runs smoothly.

Of the small grains, oats is the best for silage. Because of hollow stems, fine chopping is extremely important to give more compaction in the silo and a more uniform feed. Plant a thick stand, cut at dough, and wilt to 65% moisture.

3. Use the proper length of chop.

Fine, uniform chopping aids in packing and exclusion of air. Recommended length of cut is ¼ to 3/8 inch. This allows for adequate compaction, greater silo density, and a more uniform feed. Chopping finer than ¼ inch is undesirable, especially if silage is the only feed.

4. Provide a tight silo.

The silo operates under the same rules as a chimney. To make the fire burn hotter more air is allowed to the fire. Silos with air leaks allow passageways for air to enter the silage, resulting in respiration which increases heating throughout the silage. The silo should be checked prior to filling for leaks or holes. Examine silo doors for tightness of fit and state of repair. Caulking or rubber stripping around doors is an effective means of reducing air entrance through the doors.

5. Fill the silo rapidly—continuously if possible.

Good compaction requires considerable height of the material to provide the weight necessary to express air from the mass. The upper portion will be less dense and hold more air, which causes heating. If filling is delayed over several days, the upper layer from each filling can be noticeably different in quality.

6. Pack horizontal silos continuously.

Because there is no height to compact, tractors with front-end attachments should be used to pack the silage. Tractors should be used after each load to distribute and pack the silage evenly and firmly.

7. Apply a top seal.

Unless the silo is going to be used immediately, the top portion of the silo should be sealed with material such as black plastic

Finely tuned machinery keeps the truck moving between chopper and silo constantly. Preventable breakdowns are costly during harvest and also at feeding time when poor quality layers which were exposed during a silo filling wait are uncovered.

Nowhere is rapid filling more important than in horizontal silos. Height of the feed alone won't compact the feed and drive out the air, so use a heavy tractor to pack and distribute the chop after each load is dumped. Old tires in the background will weight the plastic cover after the bunker is filled.

to prevent contact of air to the silage surface. Regardless of how soon the silage will be fed, bunkers should be covered with weighted plastic as soon as filling is completed.

Special techniques for each crop assure top quality at feeding time

Corn. The digestible nutrient content of corn harvested for silage is generally higher than that of any other silage crop.

The variety selected for the best quality silage should be a high-yielding grain variety. Plant population for silage should be 10 to 15% higher than for grain. To enable harvesting at the correct stage of maturity, two or more varieties of differing maturity should be planted.

Corn should be harvested at physiological maturity when the kernels are at the full dent stage. Besides being the ideal stage for ensiling, harvesting at physiological maturity results in maximum total digestible nutrients per acre, gives a moisture range of 60-70% (where lowest harvesting and storage losses occur) and insures palatability, intake, and production.

If the moisture content is too low or if silage is to be made from the stalks, water can be added at ensiling to increase the moisture content. Approximately 2.5 gallons of water per ton of silage are required to increase the moisture level one percentage point.

Frost-damaged corn has a comparable feeding value to nonfrosted corn at a similar stage of maturity.

Alfalfa. Stage of maturity is the most important factor in determining silage quality of alfalfa silage, especially for first cutting. For each day cutting is delayed animal intake decreases about 2% and digestibility decreases .3% to .5% per day. The proper time to begin harvesting is in the bud stage.

Although some compromise in first cutting yield occurs, total yield is increased as the result of later cuttings.

Moisture content is the next factor of importance in alfalfa silage quality.

Wilting to 65% moisture prior to chopping results in less storage losses and more ideal fermentation. Moisture is reduced, so refermentation is not likely to occur. Once the wilted crop reaches 45-50% moisture, silages run the risk of heat damage, resulting in reduced protein digestibility.

Heat damage can be determined by analyzing for acid detergent fiber insoluble nitrogen. Heat damage is not a problem in corn silage.

Small Grains. Harvesting small grains for silage results in harvesting about twice as much TDN as when they are harvested for grain.

Oats is the best small grain for silage. Seed for a thick stand by planting 3-4 bushels per acre. Cut in the dough stage of maturity and allow to wilt to 65% moisture before chopping.

Fine chopping is extremely important in making high quality oat or any small grain silage due to the hollow nature of the stem. This allows for more compaction and a more uniform feed. □

Dr. R.K. McGuffey is assistant professor in the Dairy Science Department.

Corn: root strength studies

SDSU scientists look for corn lines with bigger, stronger roots to fight disease, anchor plants till harvest

D. Boyd Shank and **David W. Peters**

Would corn varieties with bigger, better roots prevent some of the usual ears left in the field after the picker or combine has been through?

Plant breeders at our Agricultural Experiment Station and around the country are taking a close look at corn roots to find out. Indications are that the size of the root system does indeed have a strong influence on the amount of corn plants that fall out of the reach of the picker.

Each year corn stalk lodging caused by strong winds, rootworm infestations, and root rot takes a heavy toll on the corn crop. Producers not only lose corn but valuable harvest time when lodged stalks clog machinery.

Plant breeders look at the root system as the anchor of the corn plant. It keeps the plant upright and helps draw in the minerals and water for growth and production. Although a smaller root system may provide adequate water and minerals, it will not provide the structural support that the plant needs under windy conditions. A strong, profuse root system provides a great deal more structural support than a small, poorly developed one.

Larger root systems seem to help plant through rootworm, rot attacks

Several researchers have indicated that a large, well developed root system greatly increases the tolerance of a corn plant to corn rootworm feeding damage. This means

that the plant can produce a crop even under the attack of the rootworm. Current research indicates that a large root system may be a definite advantage under light to moderate infestations of the rootworm, although this advantage will decrease as the infestation becomes heavier.

Similarly, researchers have found that plants with larger root systems tend to show less yield reduction as a result of root rot than plants with smaller root systems.

Yield reduction caused by corn rootworm feeding and root rot may be less on a plant with a large root system. A dilution effect occurs. With larger root systems, more active root area will remain to provide the plants with the necessary minerals and water for production of a crop.

Several methods have been devised by corn breeders to select superior root systems. Some involve the digging of the roots and visually grading them. A somewhat different system which has been used at the Station and the USDA Northern Grain Insects Laboratory, also at Brookings, is the root-pulling resistance method. This is a measurement of the force required to lift a corn plant vertically from the soil.

Root-pulling resistance has been shown to be strongly correlated to the size and volume of the root system. This method provides a fast and relatively easy way to compare corn root systems of various corn lines in the same plot or field. With this method, large numbers of corn lines can be evaluated.

But could too large a root system actually hinder yield performance?

Now, many breeding programs are developing new corn inbreds with large, profuse root systems. Inbreds of this type would then be used in the production of corn hybrids which exhibit these superior root characteristics in hopes of reducing lodging and its resulting loss of yield.

As corn inbreds with larger root systems have been developed, some researchers have

Corn breeder Boyd Shank knows that a thick stalked, heavy eared plant needs an equally strong root system to support it until the picker or chopper comes. Winds, rootworm, or root rot can lodge corn and lower the yield this fine tasseling promises. A large root system will have enough reserve to provide the plant's needs until harvest.

For farmers with several varieties, walking the field, digging out roots, and comparing the size of the root masses visually will tell which lines have superior root systems. But researchers need something quicker and more objective. This lever device translates corn root strength into a simple number that can be compared over the years with other varieties. A pull on the end of the 6-foot lever lifts the plant from the soil. The resistance the plant gives is strongly related to the size and volume of the root system and is measured on a gauge. (Photos courtesy of USDA Northern Grain Insects Lab, Brookings.)

questioned if a root system can get too big, become so unbalanced with the leaf area, that the plant would be unable to support the roots and produce top yield at the same time.

To gain more information about this, 66 single cross hybrids were watched at the Station at Brookings in 1977 and 1978 to see if any detectable relationship could be found between the yield and the size of the root system.

Growing conditions were excellent in those 2 years. The results of this experiment indicate that under good to average conditions, a large root system will not adversely affect yield. Future research should be able to determine whether this holds true for stress conditions of drought or nutrient deficiency. When materials needed by the plant are in short supply, the effects of any competition between the root and the developing ear may become much more evident.

So far, the development of corn hybrids with large, strong root systems appears to have a definite advantage for the corn grower. Breeders need to know more about these big root systems in more varied growing conditions. When they get more answers, perhaps they'll design corn varieties that stand up better for machinery and prevent after-harvest ears in the field. □

D. Boyd Shank is Station corn breeder and SDSU professor. David W. Peters, formerly graduate student in the Plant Science Department, is now a graduate assistant at Purdue University, Lafayette.

'Off-beat' foods: use them

If it walks, swims, or grows in the ground, this lady can come up with a way to turn it into a tasty meal.

She's more than "just another cook."

She's the kind of cook who, if she follows a recipe, hears her husband say, "you can do better than that." The kind who, when approached by the state biologist to discover why much of the state's venison goes into the dumpgrounds, couldn't answer—such cuts tasted just fine to her and her "dinner guests."

The dinner guests were a bit out of the ordinary—carefully isolated from each other and, instead of napkins and silverware, given pencils and evaluation cards to mark.

Obviously, she's not just another cook; she's been an assistant professor of nutrition and food science at SDSU and a researcher for the Agricultural Experiment Station. She's Dorothy Deethardt.

Her 23 years and 7 months on the job ended in July when she retired. But she'll never just quit.

During her research career, she has been the senior or co-author of some 45 journal articles and other publications; she has reviewed recipe books and food science publications; she developed "whea-ets," a nutritious whole grain snack food; she has written bulletins on pork, buffalo, pheasant, carp, paddlefish, cereal grains, bulgur, noodles, and sourdough.

And venison—to provide her recipes for those people who throw good meat into the dumpground.

Game animals are too precious as food source for meat to be wasted

Now that's not a typical cook, especially for one who began working part-time to supplement the family income.

"As I read about nutrition and research, I knew I wanted to do something more with what I was learning." She went on to get her MS in nutrition and food science from SDSU.

Being an only child, she thought of herself as having a "different trend of thought." Research was the answer, not teaching.

"In research, I work pretty much alone. The decisions are all mine. If I have failures, I don't get discouraged. Negative reactions are just as important as positive ones," she explained. "I have confidence in myself and know that I'll come up with an answer—whatever that may be."

But the task hasn't always been easy. Not coming from a hunting background, Mrs. Deethardt has had to ask herself more than once what she could do in the laboratory that would make a hunter's catch more palatable. She has a very firm reason for choosing to concentrate on such "off-beat" fare.

Take the day she walked into the lab to find her co-workers gathered around a sinkful of live buffalo fish.

After an initial, "oh-my-goodness," the food expert dealt efficiently and imaginatively with the fish and her fellow researchers pronounced the dishes good. Mrs. Deethardt's firm conviction is that, if a food source is available, it should be used. It should not be downgraded or destroyed.

Popular publications have given her wide acclaim in foods research

She studied the preparation of bison at the request of the National Buffalo Association which wanted to know the meat's nutritive value. She looked into pheasants when there was talk of promoting commercial pheasant raising farms and researched paddlefish before the species was labeled "endangered." Research was done on carp when wildlife specialists asked why it wasn't being used in South Dakota at a time when tons of carp were shipped out-of-state.

Bulgur received attention when it became a commodity; when the researcher's bulletins became available, the retail sale of the product increased. Wheat and triticale were studied and resulted in bulletins on noodles and "Bounty from the Bin."

Mrs. Deethardt's publications have all been reprinted which "proves that they have been useful," she noted.

"The hard part of the research is putting what I've done on paper."

But putting her gleanings into print has taken her to two international food technology meetings in Spain and Canada; the latter was an International Cereal and Bread Congress. "This is part of the reward of research," she said. It is at these meetings where she presents her papers to other nutrition and food science professionals.

The SDSU test kitchens are filled with scales, graduated cylinders, and flasks whose sensitivity in measuring is required in foods research. There's nothing, however, that can replace experienced hands that can feel the consistency of a dough. Even when Dorothy Deethardt alters a recipe (and she invariably does) she is not a taster. Her recipe books, written through nearly 24 years of research, are available at county Extension offices or from the Ag Bulletin Room, SDSU.

"It gives me a lift to be considered an authority among other professionals in the field," she explained. "It is especially meaningful to me when, after I present the paper, these professionals ask questions and show an interest in my research."

Next cookbook will be more general: family recipes for good nutrition

As the years go by and experience deepens, she sees a change in trends within herself.

"I started out my research by aiming at the scientific world, but now I've changed my focus to the homemaker; that's where my interest is," she stated. "I want to help to improve the nutritional status of the family."

In her retirement, the nutritionist will further work to achieve that goal.

"I plan to publish my own chit-chatty recipe book with common, everyday recipes plus some metric conversions, since that is what I work with in my research. I have been encouraged to write a recipe book by so many people because of the little things I do to recipes. My daughter has especially encouraged me to write down my own mother's hand-me-down recipes so they can be used by others.

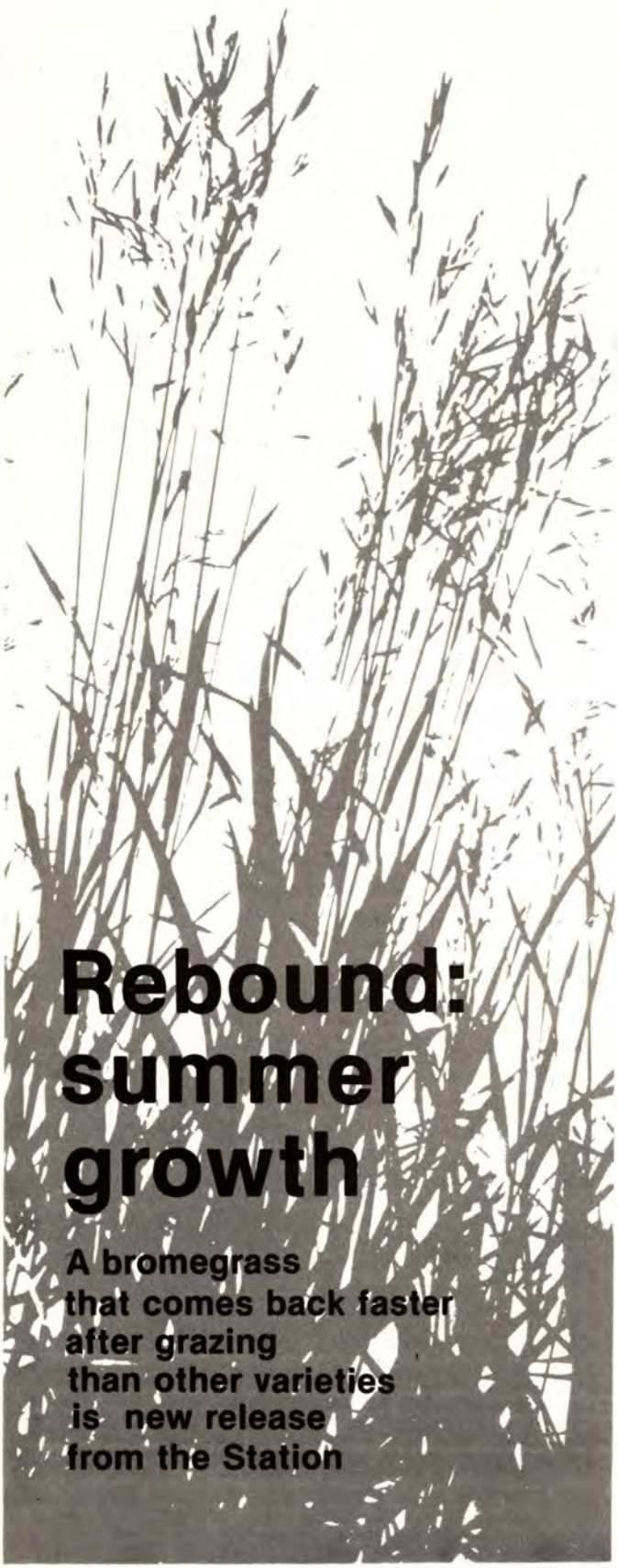
"I alter most recipes and, thus, make them my own. When I find a recipe I want to try, I usually don't have all the ingredients. So, I substitute. It's usually the unaltered recipes that get a 'It doesn't need to come again' response from my family."

With all the recipes she's tried and all the changes she's made, Mrs. Deethardt is not a taster as she cooks. "I know what I've done to the food so I know what it should taste like. It's because of that that I'm sometimes surprised food comes out as good as it does."

That's an expert for you.

Her SDSU co-workers have said good-bye to Dorothy Deethardt the researcher and hello to a cookbook writer who will have her tried-and-tested recipes on the tables of those same South Dakota families whom she has served for 24 years. □

The writer is Deanna V. Boone, family living editor in the Ag Information Office.



Rebound: summer growth

A bromegrass that comes back faster after grazing than other varieties is new release from the Station

A new smooth bromegrass developed at SDSU does something no other South Dakota grown bromegrass variety can. It continues growing through the heat of summer. It's name?

Rebound.

To be sold to the general public for the first time this fall, Rebound has one more step to go since the preparation for its release began more than 10 years ago. That final step is for growers to try it.

"We really can't tell the outcome of a variety until it has been tried and tested by a number of farmers in varying situations across the state," says James G. Ross, Agricultural Experiment Station plant breeder who has spearheaded the development and release of this grass.

While others are already enthusiastic about Rebound, Ross adds the caution that comes with more than 30 years experience working with the unpredictability of South Dakota climate and soils—and plants.

Causing much of the enthusiasm is the possible increase in water efficiency that growers may be able to get with Rebound as compared with other available bromegrass varieties including Lincoln, the most common South Dakota variety.

With Lincoln and the others, no amount of water or fertilizer will keep them from going dormant in South Dakota summers. But Rebound, with its constant regrowth capacity, has appeared in SDSU tests as a good choice, whether under irrigation or on dryland.

Compared with Lincoln, Rebound is more of a bunch type plant with tall regrowth. It tends to grow more up than out, which may lead producers to increase seeding rates slightly more than usual.

Original 44,000 seedlings were whittled to four Rebound parents

Plenty of work went into producing Rebound.

It started probably in the United States in 1884 when bromegrass was first introduced from the Old World.

"Brome was quickly one of the most valuable cultivated pasture and hay species," Ross says. "Smooth bromegrass formed the most desirable forage mixture with alfalfa of any grass tested by our Agricultural Experiment Station even before the beginning of this century."

Bromegrass, a winter hardy perennial, has grown for 60-70 years in eastern and central South Dakota, though it tends to become sod bound and low producing unless fertilized or renovated, according to the scientist. It is a relatively high yielding forage grass all over

After flowering, most bromes go dormant until cooler weather. Rebound continues to put on vegetation growth. It is a tall plant and tends to lodge at maturity. Since it was bred for pasture production, this is not a concern for most growers.

South Dakota but grows best in fertile sandy loam or silt loam soils with plenty of moisture. In combination with alfalfa or with applications of nitrogen fertilizer, stands produce well for many years. Even the early varieties were highly palatable and digestible when grazed or used as hay.

So, in essence, what Ross had in mind when he began this project, funded by the Water Resources Institute and the Station, was to make a good species better.

His plans began to jell after he returned in 1968 from spending 2 years with a team of scientists helping to establish a land-grant type university and agricultural improvement program at Ataturk University in eastern Turkey.

"When I came back I realigned my goals. Trying for a bromegrass with regrowth characteristics through a South Dakota growing season was one of them," he says.

By the fall of 1971, 44,025 seedlings had been transplanted from the greenhouse to an 8-acre plot near Brookings.

"This was probably one of the most unusual parts of the procedure for this variety," Ross explains. "Usually we start with far fewer plants."

The majority of the plants—29,039 to be exact—were of the Saratoga variety, which had been released by Cornell University, NY, in 1953. Several other varieties with desirable attributes were added, as well as plants for control purposes. All were kept at optimum moisture and fertility.

Then the next year, Ross chose 63 plants that showed good regrowth after each cutting. These plants went through extensive screening for the next 2 years to check many kinds of agronomic characteristics such as seed set, disease resistance, height, vigor, leafiness, and coarseness.

Finally the selection came down to four plants, now considered to be the parents of Rebound.

Rebound grows taller, faster than other bromes, will lodge when mature

Ross explains that Rebound resembles Saratoga in its ability to produce aftermath growth during the summer, but it differs in other ways. For example, Rebound generally shows taller aftermath production. Rebound has higher in vitro digestibility, regrows more quickly after being cut, and is more of a bunch-type plant than Saratoga.

According to Ross, Rebound tends to lodge as it becomes more mature. However, this is

Lincoln, on the left, is the most common South Dakota variety grown. In tests, Rebound has been consistently superior in yield. On dryland, Rebound will use what rains may come during regrowth periods; Lincoln can not.

Jim Ross, who has successfully developed Oahe intermediate wheatgrass and summer switchgrass, started with over 44,000 brome seedlings of different varieties, an exceptionally high number of starter plants. The next year he weeded out plants that showed poor regrowth after cutting and was left with only 63 survivors. Continued screening for desirable agronomic characters brought the selection to four plants. Rebound is aptly named; it grows more quickly after cutting than Saratoga.

not a factor for pasture production for which this variety was selected.

"In all instances but one, Rebound had advantages in summer regrowth over Lincoln in the tests done by SDSU," Ross says. "The exception occurred at second cutting at Redfield in 1977 when unusually low temperatures came during the regrowth period. In this instance, Lincoln was able to produce more than normal.

In addition to tests at Brookings and Redfield, Rebound was grown at Highmore and near Rapid City.

The most significant increases in yield, of course, occurred with plots under irrigation. Typical yields at second cut were 130% of the yield of Lincoln. One test at second cutting amounted to 165% for a 2-year period of Lincoln at Brookings. Yield with mixtures of Rebound and alfalfa was 112% of Lincoln and alfalfa over a 4-year period at Redfield.

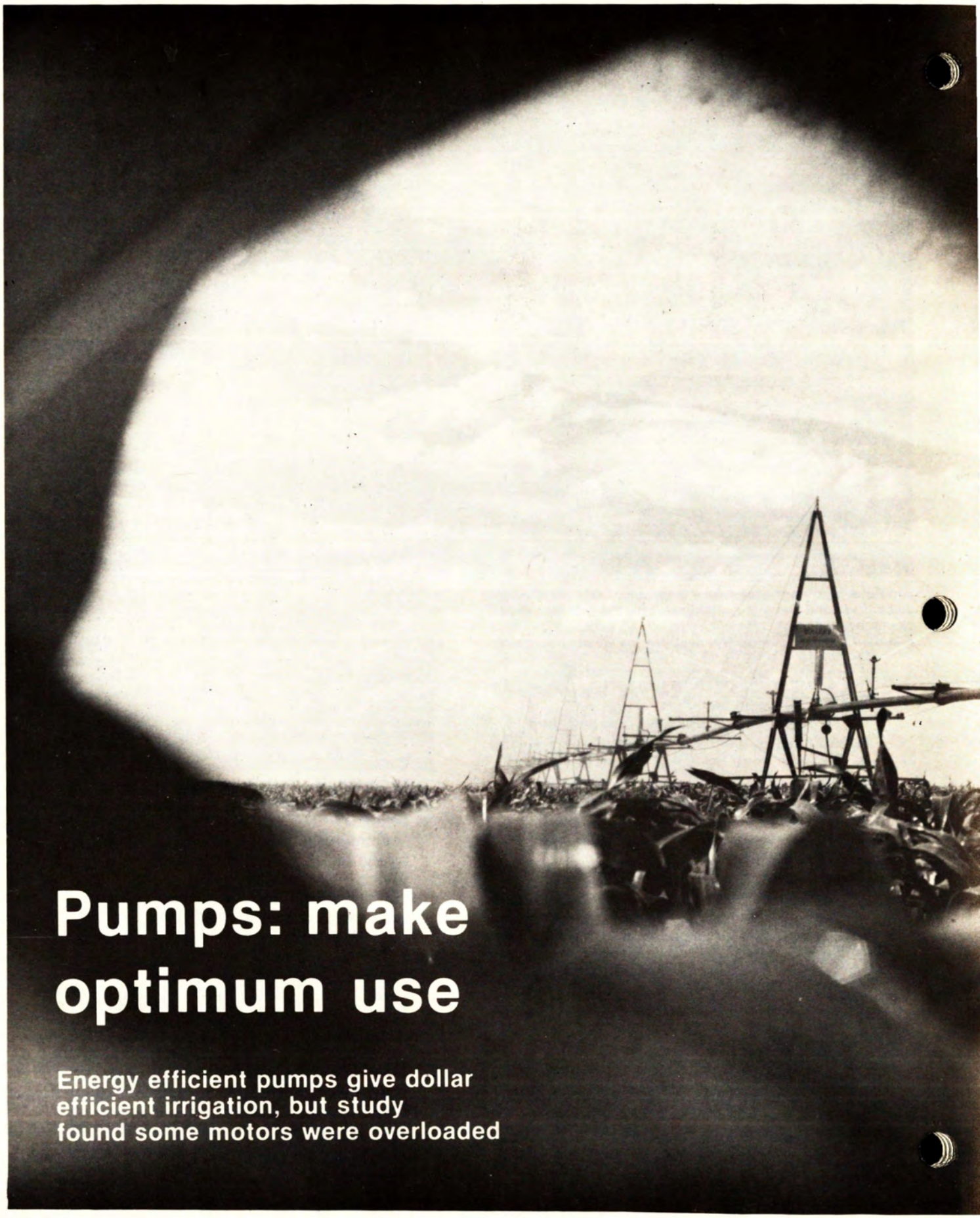
With dryland practices, the yield increases at second cut have not been as dramatic but will generally produce 118% of Lincoln. The key here seems to rest with getting the usual high temperatures during the regrowth periods as well as rainfall. Rebound's advantage for dryland growers is that if rain comes the plant will make use of it, while Lincoln will not.

Ross also points out that total yearly production from Rebound may not necessarily exceed total production of Lincoln. It appears to be similar, but Rebound has the added advantage of growing during the heat of the summer.

Foundation seed for Rebound was produced by the South Dakota Foundation Seed Stock Division Corporation in conjunction with the Station. Certified seed for commercial production will be available this fall from three experienced seed dealers. They currently have 130 irrigated acres planted under the supervision of SDSU.

What happens with Rebound after this fall depends on the farmers, who are part of a large team of people that make this and other South Dakota varieties possible. But knowing the thoroughness that Ross demands and looking at his past development of Oahe intermediate wheatgrass and summer switchgrass, many growers probably have already decided to give Rebound a try. □

The writer is Jacqueline Ullery, assistant information specialist, Ag Information Office.



Pumps: make optimum use

Energy efficient pumps give dollar efficient irrigation, but study found some motors were overloaded

Bruce Jennings and **Darrell DeBoer**

The irrigation energy bill can represent a sizable part of total production costs for irrigated agriculture. Using an energy efficient pumping plant is one step toward maximizing returns from irrigation energy dollars.

An irrigation pumping plant consists of two components, a pump to deliver water and a power unit to drive the pump. The efficiency of a pumping plant is a measure of the output work of the plant from a given power input. It can also be expressed as:

$$\text{Pumping Plant Efficiency} = \frac{\text{Power out}}{\text{Power in}}.$$

Several factors—including pump design, adjustment, and wear—can affect pump efficiency. Suppose you need to pump 900 gallons per minute (gpm). Either pump A or B in Figure 1 could give satisfactory performance at 900 gpm discharge and 40 feet of head per stage. However, Pump A will do the job at greater than 80% efficiency while Pump B would operate at about 65% efficiency. Pump B will provide an 80% efficiency when 1400 gpm are needed.

Improper pump adjustment and pump wear can also cause a decrease in pump efficiency. Initial pump adjustment is performed by the pump installer. Subsequent adjustment should not be necessary unless wear occurs. A qualified pump technician will be able to determine when adjustment will improve pump performance.

Wire-to-water efficiencies of most pumps tested met state standards

Thirty-three irrigation pumping plants were studied during 1977 and 1978. The plants were located in eastern South Dakota and were all powered by electricity. Input energy, in the form of electricity to the motor, and output energy, in the form of water power from the pump, were measured for each plant. Efficiency values associated with such measurements are often called wire-to-water efficiencies.

The efficiency values (Table 1) ranged from 47 to 73% with an average value of 63.4%.

Table 1. Pumping plant efficiencies.

	Percent						
	45-49	50-54	55-59	60-64	65-69	70-74	Total
Number of plants	1	1	7	10	9	5	33
Percent of total	3	3	21	30	27	16	100

In general, the pumping plants tested in this study were operating at a high efficiency and are not in need of repair or major adjustments. The basis for such a statement is demonstrated in Table 2 where the field results are compared with South Dakota standards for irrigation pumping plants. The standards were developed to reflect acceptable performance characteristics for pumping with good maintenance practices. More than 50% of the plants exceeded the 95% standards value.

An interesting sidelight of the pump efficiency study was the estimation of load factors for the electric motors associated with the pumping plants (Table 3). A total of 41 motors were tested.

A load factor of 100% indicates a fully loaded motor, while a load factor of over 100% indicates an overloaded motor. Load

Table 2. Performance ratings of electric irrigation pumping plants.

	Percent of South Dakota standard					
	Less than 85	85-89	90-94	95-100	Exceeding standard	Total
Number of plants	2	7	6	6	12	33
Percent of total	6	21	18	18	37	100

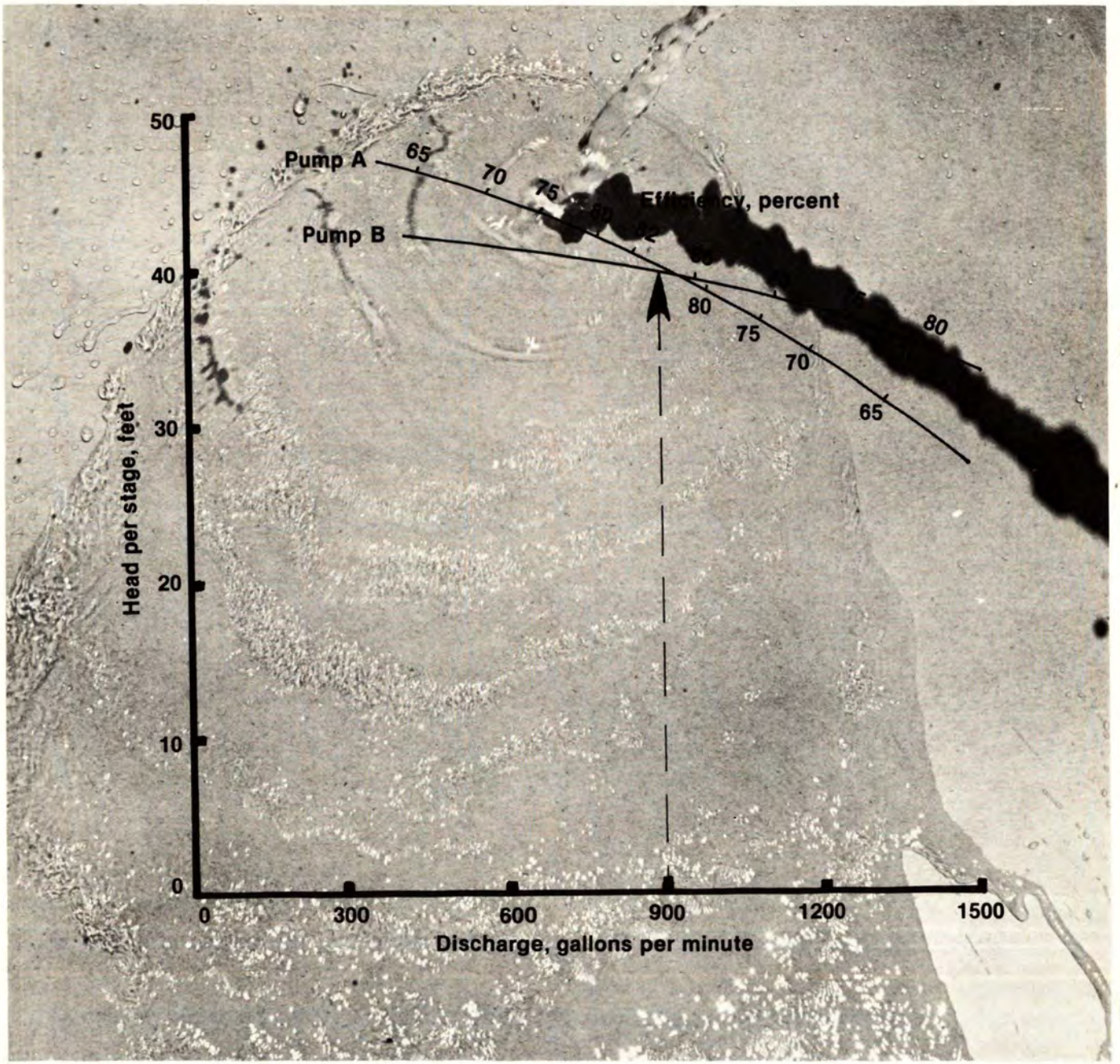


Figure 1. Comparative pump curves.

Pump design can affect efficiency, says Darrell DeBoer, right, SDSU ag engineering professor. Once the pump is installed and adjusted, the most critical factor becomes wear. Keep full records of water used and cost of energy. Don't hesitate to replace or repair; an efficient pump saves you money. (Photo page 18 courtesy of Valmont Industries.)

factors were estimated by measuring power input to the motors and assuming a motor efficiency of 90%. Forty percent of the motors were operating above a 100% load factor.

A slight overload is permissible for most industrial electric motors if a suitable environment is provided. Irrigators who operate electric motors at or above full load must provide a well ventilated, shading structure or suffer the potential consequence of reduced motor life caused by increased motor temperatures.

Proper pump and power unit selection will insure an efficient irrigation pumping plant. Proper maintenance and periodic testing will help keep the pumping plant performing efficiently for many years. Irrigation records which contain annual checks on pumping plant discharge and discharge pressure can be used to monitor the performance trends of pumping plants. Pumps and power units should be replaced or repaired when the cost of wasted energy exceeds the amortized annual cost of the required repair. □

Table 3. Load factors of electric motors as power units for irrigation pumping plants in South Dakota.

	Percent						
	80 or less	81-90	91-95	96-100	101-105	Above 105	Total
Number of units	6	7	7	5	8	8	41
Percent of total	14	17	17	12	20	20	100

Most pumps tested met efficiency standards; but shading becomes important as pumps approach overload. Otherwise, the higher motor temperatures will reduce motor life.

Bruce Jennings is a former research assistant and Darrell DeBoer is a professor in the Agricultural Engineering Department.

RSI: eye on the environment

When a senator, a college president, and a researcher teamed up, space technology began to have real impact on agriculture

A special birthday is being celebrated on the campus of SDSU at Brookings. The Remote Sensing Institute (RSI) is 10 years old.

It's a happy event for Vic Myers, Institute director since Day 1, for former SDSU President H.M. Briggs, for Sioux Falls businessman Al Schock, and for literally hundreds of others—all of whom helped breathe life into an Institute which has become an "institution" in the best sense of that word.

It's also a happy event for agriculture, hydrology, geology, geography, the environment, natural resources, rural and urban development, energy conservation, and the hungry peoples of the world—all of which have benefited from the pioneering scientific efforts of the Institute during the past decade.

The Institute is almost universal in the applications of its work, and its stock-in-trade, remote sensing, is really an ancient concept meaning, simply, to collect information at a distance from some object.

Institute reverses age-old method, "fingerprints" earth from space

While astronomers have done this with planets and stars for centuries, the Institute has reversed the process; it uses space as a vantage point for viewing earth.

Remote sensing, as it is known today, had its beginnings in the military—especially in the Pacific Theater during World War II. There, it was developed as a technique for reconnaissance and for piercing camouflage.

Some experimental work in the new science was being done by the U.S. Department of Agriculture and various universities during the 1960's, but, after the establishment of RSI in South Dakota and several similar institutes at other universities, the application to agriculture and rural areas was greatly accelerated.

When energy from the sun spills across the land, each object it strikes will reflect or absorb the rays in a unique manner. This is a "fingerprint" which is visible to special sensing equipment employed by the Institute.

Photographs from aircraft equipped with special cameras and imagery from satellites are used by the Institute to collect these fingerprints from vantage points ranging from low-level passes to orbits several hundred miles in space.

The result, when analyzed, constitutes a portrait of important earth features such as ground water, crop damage and maturity, lake water quality, pollution, insect infestations, and even the adequacy of insulation in the homes and businesses of an entire city.

Globe-circling staff is composed of special people in special jobs

To conduct these activities, the Institute has assembled a staff of 17 professional and 8 clerical employees, augmented by both

graduate students and part-time students. Hydologists, soils scientists, geologists, engineers, physicists, computer experts, wildlife specialists, pilots, artists, typists, photographers, and others represent the diversity of disciplines required for the Institute's special work.

"Special people are attracted to special jobs," theorizes Don Moore, head of the Institute's Education and Training Section.

Working individually and in teams, Myers' staff has undertaken immense amounts of activity. Last year alone, they engaged in 17 major projects, delivered 17 professional papers at scientific meetings, secured funding from 20 separate sources, and conducted 16 consultancies with various agencies, organizations, and foreign nations **besides** their daily research development, service, and training activity at the Institute.

One staffer says he circumnavigated the globe three time during 1978. Others represented RSI on most continents of the world at one time or another during those 12 months.

RSI wouldn't have gotten off ground without help from an old friend

While the Institute is 10 years old, efforts to create it at SDSU date to the mid-1960's.

H.M. Briggs says he was first contacted about the possibility of developing a remote sensing institute by South Dakota's then senator, Karl Mundt "2 or 3 years before the general public knew anything about it. Karl had been shepherding this idea for years.

"Karl had the feeling that this area of the nation ought to be getting some of the big things that were then coming out," Briggs explained. "It was one of the real enjoyable things I had the chance to do while I was SDSU president."

Mundt had obtained a verbal commitment from officials of U.S. Geologic Survey and the Bureau of Reclamation for grants to support some experimental work the agencies wanted done. The grants would be tremendously important in getting the fledging Institute on its feet.

The first hurdle was to find the right man to head the Institute.

"I kept at it, asking for someone who was involved in remote sensing and had a good agricultural background. Quite a few said, why, there's this guy in Texas named Vic Myers who's using infrared aerial photography on cotton. So it seemed that all signs pointed to Vic."

Funding for the Institute then began to develop, with Mundt, Briggs, and others constantly involved. A line item in the U.S. Department of Agriculture budget, a grant from the National Aeronautics and Space Administration, pledges from South Dakota Conservancy Subdistrict, contracts from the U.S. Geologic Survey, and others—all of it began to take shape.

Vic Myers says of the time, "It was pretty rough to get funding when you had no track record or no reputation for success."

The next need was for an aircraft equipped to handle remote sensing. Director Myers explains that a Department of Defense aircraft probably could have been obtained, but that modifications would have required more funds than the Institute could then afford.

Re-enter Karl Mundt.

Briggs explains, "You have to understand that Karl was in a position to talk to these fellows on the federal level, and that he could talk pretty well. After all, these fellows were pretty much interested in Karl Mundt because he was just about the ranking Republican in the Senate at the time, and he sat on all the important committees that were involved in the appropriations for those people.

"We had to have an airplane, and the U.S. Geologic Survey had one. Karl kind of leaned on U.S.G.S. to loan us the plane. They did. . . fully equipped. Then, boy, we were in business."

"U.S.G.S. probably did more to come to our rescue in those early days than anybody else," agrees Myers.

For Remote Sensing Institute and the EROS project which followed, "the darkest moments occurred about the time Karl Mundt had a severe stroke," said Briggs. "Here we were losing our leadership in Washington, our guiding light and the main steam for the project all going out at one time. And it was really quite a blow when Karl had that stroke as far as EROS was concerned.

"But Senator Milton Young of North Dakota was also interested, and Al Schock was a real fireball (in enlisting Young's aid)," he continued.

Schock was then chairman of the Remote Sensing Institute advisory committee.

"Al should get a lot of credit for keeping up interest in the state," Briggs said. "He'd go to Pierre before the legislature and talk to them about the potentials and how and why we needed a little seed money for some work in South Dakota. Al, I would say, is one of the unsung heros in South Dakota."

Inflight on the RSI plane, the control console allows data coming in to be closely monitored. Adjusting for thermal infrared scanning results in a strip chart of solar radiation.

The world leader in ag remote sensing also helps you save home energy costs

The Institute's first years were primarily involved with experimental work, but it since has done a wide variety of research and application including aquifer mapping, wildlife and livestock counts, spotting plant diseases, and water quality studies—including feedlot runoff and pollution monitoring. It also has assessed wildlife habitat and conducted range management and soil moisture studies.

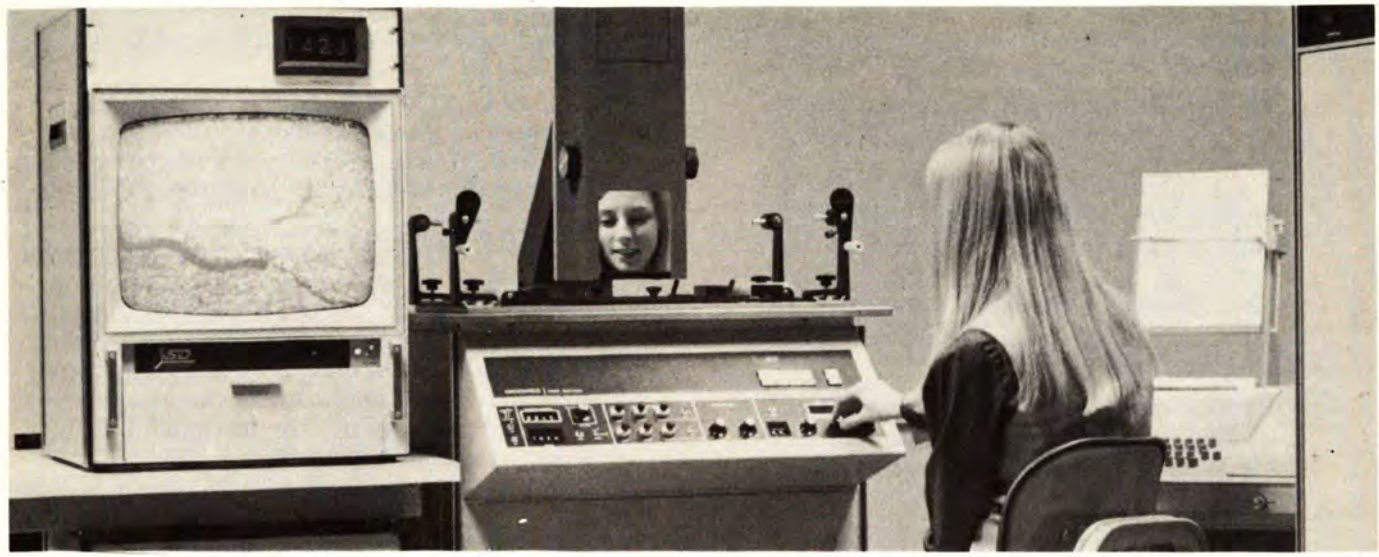
But the earliest significant RSI contributions to South Dakota, in Briggs' opinion, "were the soil survey and tax assessment work—and showing potentials of types of soils.

"We were also able to get very much involved in Dutch elm disease," he recalled, "and we had a great potential in that. But, of course, about the time we got that worked out, DDT was banned, and we needed this if we were to control that beetle.

"We could have checked the beetle if it weren't for that," he said. "I don't think there's any question about it. We could overfly and find out what the ranges of the thing were. We were tracing it right out of Sioux Falls on north, and we had a beautiful chance to head the thing off.

"One of the really highly publicized things that RSI has done has been in overflying our cities, not only in South Dakota, but in various areas of the nation, and using thermography to detect heat loss from poorly insulated houses and business places," he went on. "We've also done some fine work in conjunction with the South Dakota Geologic

Vic Meyers, RSI director, is ready to install a bank of four cameras in the plane. They can photograph from 13,000 feet. NASA aircraft and satellites take over at higher altitudes.



SADE (Signal Analysis and Dissemination Equipment) is a laboratory of specialized, remote-sensing, data processing devices. The control board is being used to convert a transparency into digital data. A segment of Landsat satellite data is displayed on the monitor.

Survey and the Geology Department at the University of South Dakota on the surface and subsurface water in the state.

"I remember we were pressed into service after the Rapid City flood in 1972, and some of our photography helped determine the outlines of the flood plain which is now the green belt in Rapid City.

"And the Visiting Scientist Program has spread the fame of South Dakota and SDSU into some remote regions of the world where nobody would even have heard of them.

"I think we can safely say that we are 'the spot' that is farthest along in the use of remote sensing in agriculture in the world today," he said. "Our basis has always been toward agriculture and rural areas, while others have been more involved in worldwide phenomena such as ocean currents."

Remote sensing shows how we care for, or mistreat, our world

Activity of RSI has since reached out to the world. Both the State Department at Washington, D.C., and the United Nations in New York know of RSI and both have helped arrange for Institute services to foreign nations.

Perhaps the "hottest" service at present, according to Myers, is the monitoring of desertification, or the changing of once fertile lands into deserts—a phenomenon Myers terms mostly man-made.

"Desert areas of the world are definitely increasing," he says. "Very much so."

Marginal lands are being overgrazed. Livestock numbers are allowed to increase during wet seasons to the extent that they prevent vegetation from rejuvenating fully after periods of severe drought. Demand for firewood not only cuts into brush and timber supplies, but, in many nations, manure is burned for cooking fires instead of leaving it to enrich the soil. The result: ever increasing acreages of desert, a condition which will have world-wide impact on food supply.

Outreach activity goes beyond desertification studies. In Mexico alone, RSI aided scientists there to assess about 102 million acres of land for better water utilization. In the process, RSI also trained Mexican scientists and engineers to be self-sufficient in using remote sensing technology in other resource studies.

A resource inventory and study for Sudan covered almost 100,000 square miles. The region was mapped for soils, vegetation, geology, and land use by interpretation of Landsat satellite data from both the wet and dry seasons. Aircraft reconnaissance and ground surveys over the 18-month project completed the work.

Armed with such information, the Sudanese government now knows, among other things, the locations for potential sources of aggregates for building materials and how a huge swamp can be channelized to save 12 million cubic meters of water per day.

A particularly note-worthy service has been the Visiting Scientist Program, the first of its kind, developed in conjunction with the U.S. State Department Agency for International Development and the United Nations. It's a matter of transferring new technology to developing counties—but through a unique approach.

The program is now the "greatest challenge" to the staff, in Myer's words. "We commit one of our staff full-time to each four visiting scientists for the duration of their stay, which can last from 6 months to a year."

It's a "hands-on" experience for the scientists, who are trained not only to use remote sensing technology themselves, but also to train other scientists in their home nations. During the training, each scientist tackles at least one major problem for his home government.

Participants in the program have come from Nepal, Sudan, Turkey, Mauritania, Senegal, India, Chile, Bangladesh, Mexico, Spain, and Zaire.

What is in RSI's future, say, 20 years from now? Myers sees some definite projects ahead.

"The space shuttle will generate a lot of experimental programming, and NASA has in the planning stages an agricultural satellite which should become operational in about 5 years. We have a proposal in right now to NASA, which is getting very favorable consideration, which involves cooperating with the Bureau of Reclamation on irrigation scheduling," he said.

The irrigation scheduling project will involve using reflectance, temperature, and microwave data from aircraft and spacecraft to estimate the need for irrigation by various crops.

And in terms of equipment, the Institute is now acquiring some sophisticated analysis capability to analyze data, but, "equipment costs in this game are very high," according to Myers, "and though we continually strive to come up with these funds, our acquisition of equipment usually lags far behind our actual needs."

In the words of Karl Mundt: remote sensing "is a program of and for the people who wish to see their environment maintain its quality and to improve that quality where necessary."

It's a birthday worth celebrating, in Myers' estimation. □

The author is Larry K. Tennyson, information specialist, Ag Information Office.

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Publications off the press

The Agricultural Experiment Station and the Cooperative Extension Service distribute a large variety of publications to South Dakota citizens. Your county Extension office has free single copies for you.

These publications list the new and revised subjects off the press between March 1 and May 31, 1979.

FS 353, Checking small plot weed sprayers (rev)
FS 429, Soybean production (rev)
FS 529, Alfalfa varieties (rev)
FS 666, Heat stroke
FS 692, Set aside acres for 1979
FS 698, Foster pens
FS 699, Arbor Day (for young people)
FS 716, Landscaping your home
FS 717, AGNET, a computer service at your fingertips
EMC 775, Sorghum varieties
EMC 778, Hessian flies
EMC 800, What fish do I stock?
EMC 801, Where do I get fish to stock?
EMC 802, Community goals checklist
EMC 803, Curbing the costs of everyday living
EMC 805, How to go broke with plenty
EMC 809, Controlling problem moles
EC 683, Insecticide recommendations for 1979
EC 722, Planning for rural industries: local employment
EC 723, Organizational objectives
EC 724, Planning and holding productive meetings
EC 725, Effective use of committees
EC 726, Decision making and problem solving
EC 729, Nursery plant source list
C 226, Budgets for major crop enterprises in South Dakota
TB 45, Simulated hail damage on oats
B 663, Eureka!
B 666, Lincoln County rural water system: growth impacts
AES 13, Irrigation: your water, your soil

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